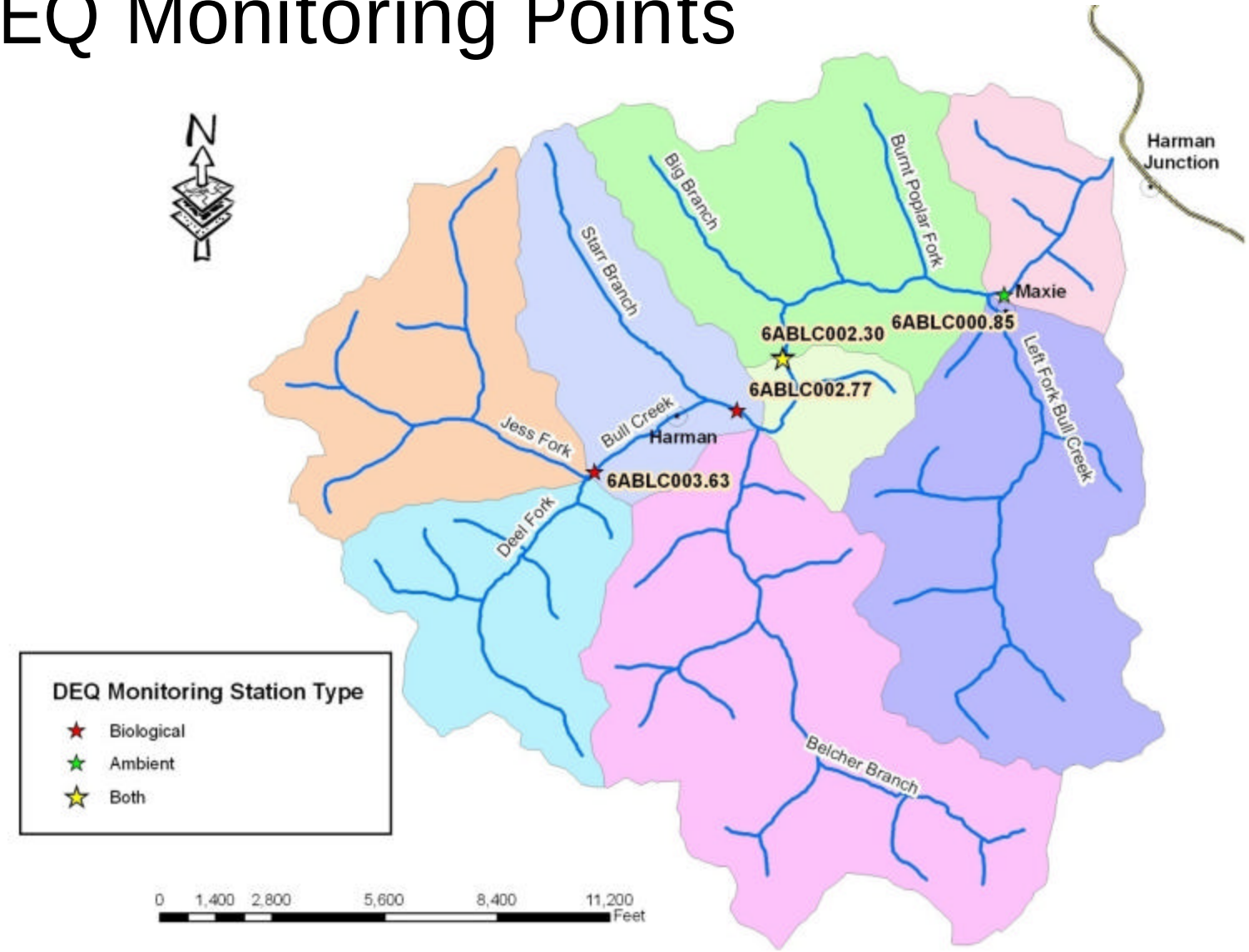
Bull Creek Phased TMDLs for a Benthic Impairment

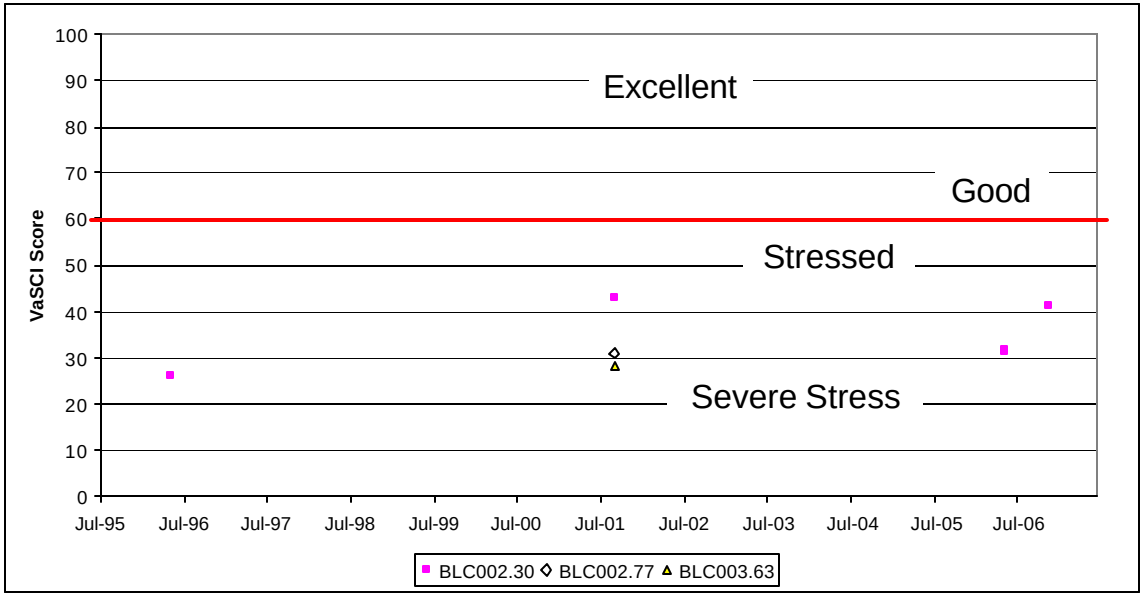
Public Meeting
January 14, 2010
Riverview Elementary School
Grundy, Virginia

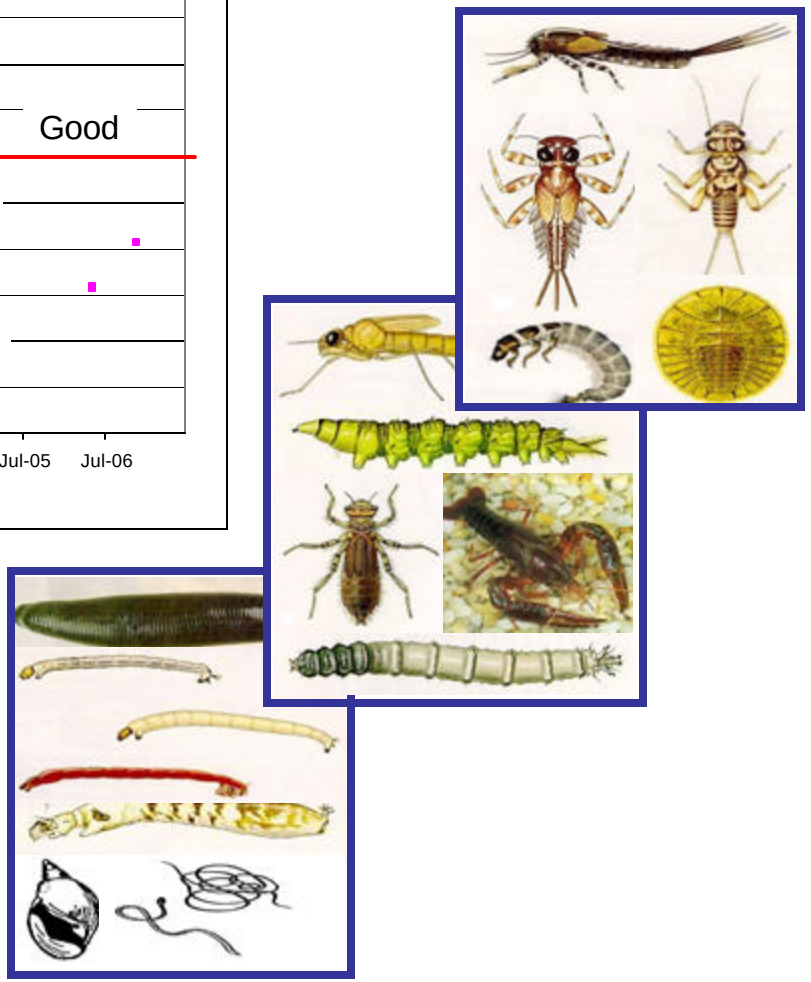
Gene Yagow

DEQ Monitoring Points



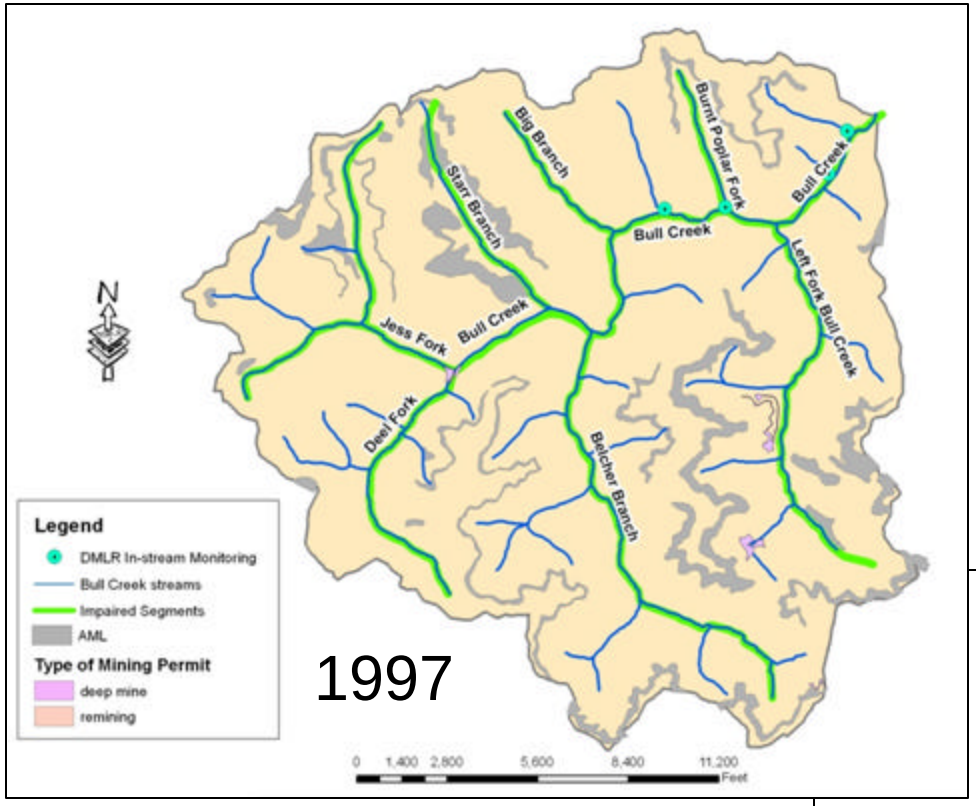
Basis of the Biological Impairment

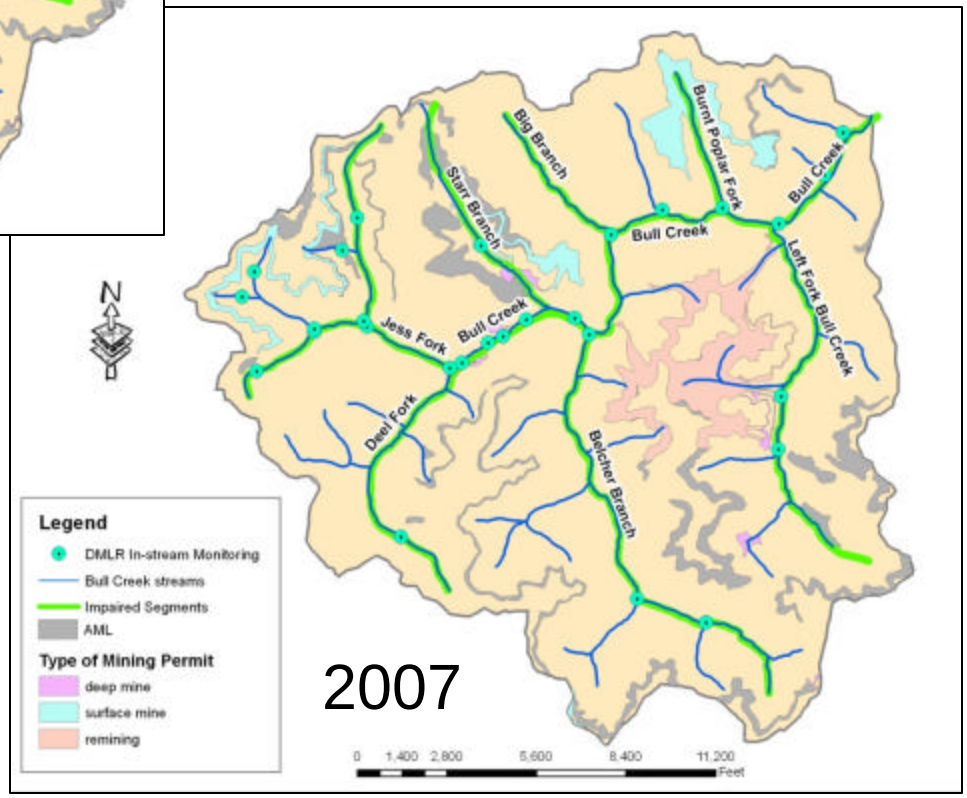




Benthic macro-invertebrates

- Abundance
- Diversity
- Pollution tolerance


Big Branch
Burnt Poplar Fork
Bull Creek
Starr Branch
Bull Creek
Left Fork Bull Creek
Jess Fork
Bull Creek
Deel Fork
Belcher Branch
N
Legend
DMLR In-stream Monitoring
Bull Creek streams
Impaired Segments
AML
Type of Mining Permit
deep mine
remining
1997
0 1,400 2,800 5,600 8,400 11,200
Feet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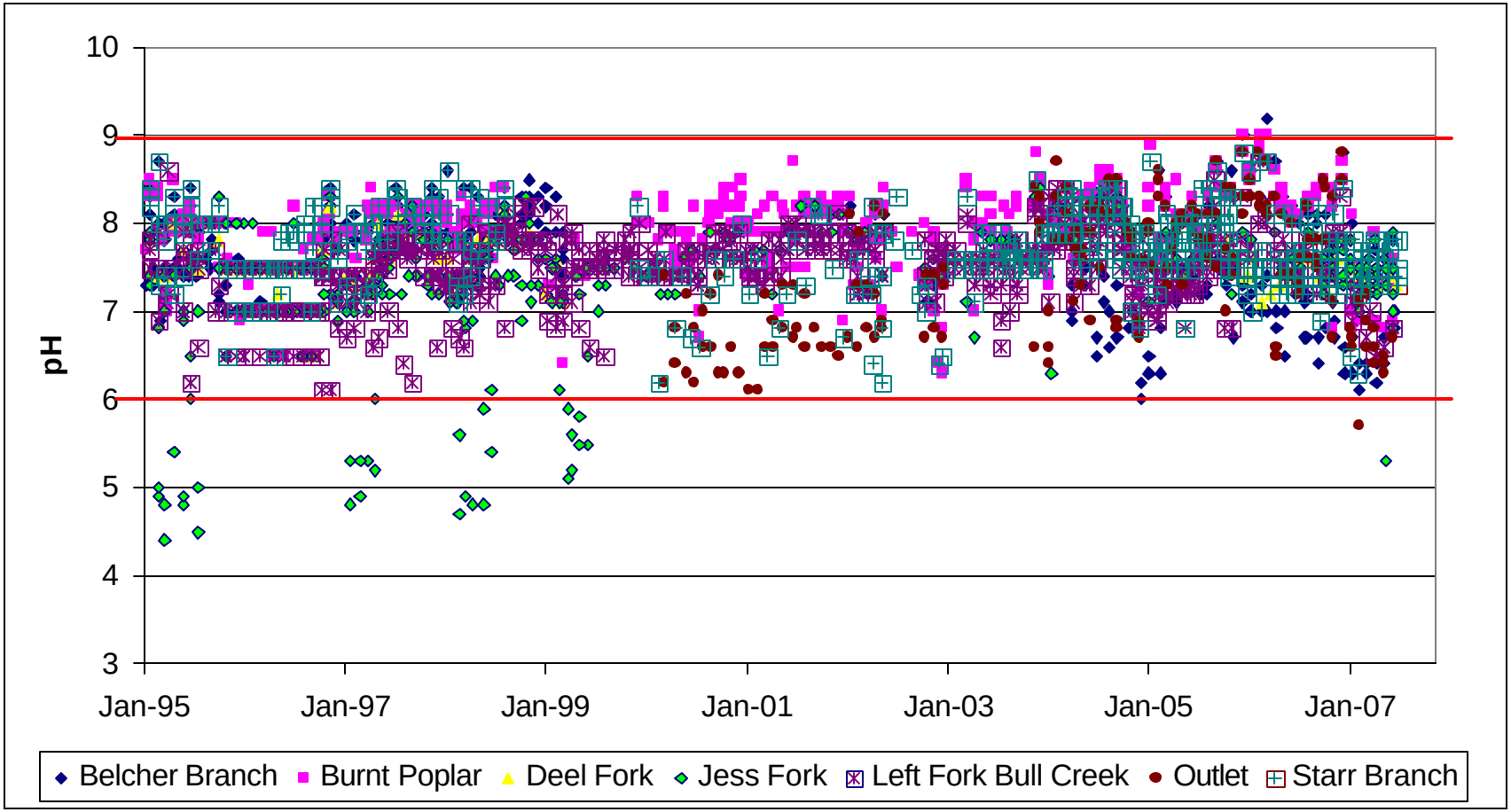
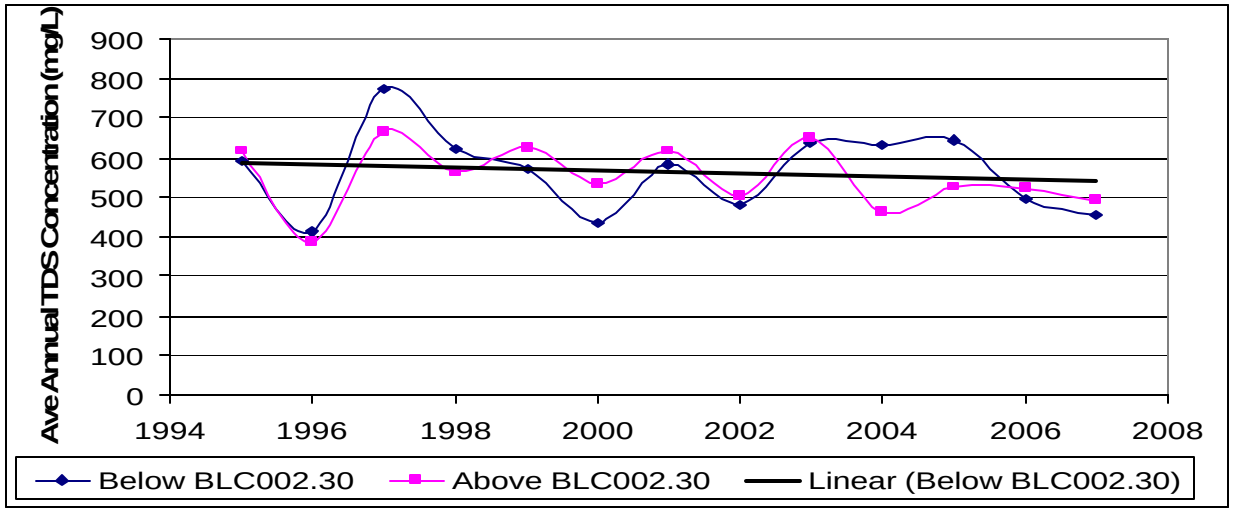
Type of Mining Permit
deep mine
surface mine
remining
2007
0 1,400 2,800 5,600 8,400 11,200
Feet

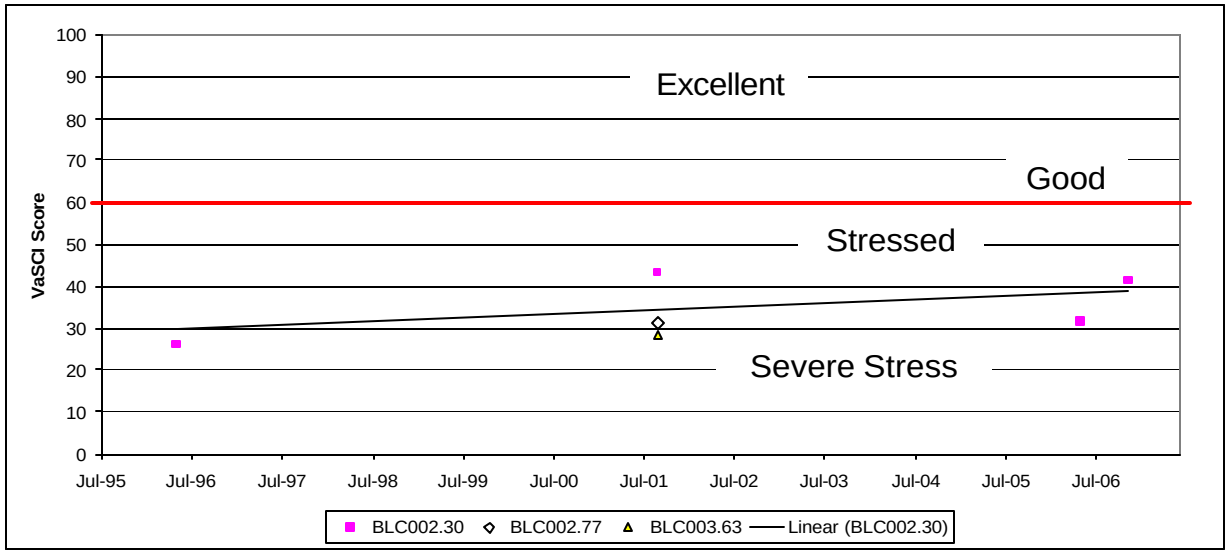
DMLR pH Monitoring Changes over Time



Association of TDS with VaSCI

DMLR In-stream
~ 600 samples
~ 50 sites





Habitat Sediment Metrics

StationID	BLC002.30				BLC002.77	BLC003.63
Collection Date	05/21/96	09/13/01	05/15/06	11/27/06	09/13/01	09/13/01
Channel Alteration	18	15	17	18	14	18
Bank Stability	4	12	14	14	15	14
Bank Vegetation	18	13	11	13	11	12
Embeddedness	6	4	4	7	7	6
Channel Flow Status	17	15	18	19	15	14
Frequency of Riffles	17	18	18	18	18	18
Riparian Vegetation	9	12	10	13	6	6
Sediment Deposition	11	7	8	10	6	4
Substrate Availability	18	16	16	17	11	11
Velocity/Depth Regime	14	9	10	9	9	9
10-Metric Total	**132**	**121**	**126**	**138**	**112**	**112**

- Habitat metric score assessed as "marginal" or "poor".

Stressor Analysis Summary

- Original impairment partially caused by low pH, high TDS, sediment, and unspecified contaminants
- Suspected sources: discharge from a now defunct coal processing plant, AML, barren areas, and mining
- Coal plant is gone, pH back to normal, mining increases, minor improvements in VaSCI, habitat metrics still poor
- Sediment and TDS appear most likely causes currently

Changes since the 09/23/08 Public Meeting

- TMDLS were designated as “phased” TMDLs due to uncertainties in pollutant load distribution among identified sources.
  - Between AML and mining
  - Between sources contributing to groundwater loads
- Correction to the classification of the “barren” land use as a non-mining land use, as originally intended.

Changes (cont.)

- Sediment TMDL
  - Used “existing” loads as the basis for reductions, rather than “future” loads that assumed unlimited disturbed areas within each mining permit.
  - Changed simulation period to 1995-2007, which corresponds with the period after which DMLR began electronic record keeping. Previously, the simulation period was 1985-2003.
  - Calibrated the GWLF model using DMLR observed flow and TSS data to ensure closer comparability with DMLR accounting procedures for regulated permit waste loads.

Changes (cont.)

- TDS TMDL
  - Updated the representation of direct mine discharges.
  - Separated interflow background loads for non-mining land uses from permitted mining waste loads.

Phased TMDLs

- Acknowledges uncertainties in load estimates and distribution of sources.
- Requires additional monitoring during a 2-yr period.
- Allows for adaptive implementation during that period with no additional permit requirements.
- Requires revision of the TMDL at the end of the 2-yr period.

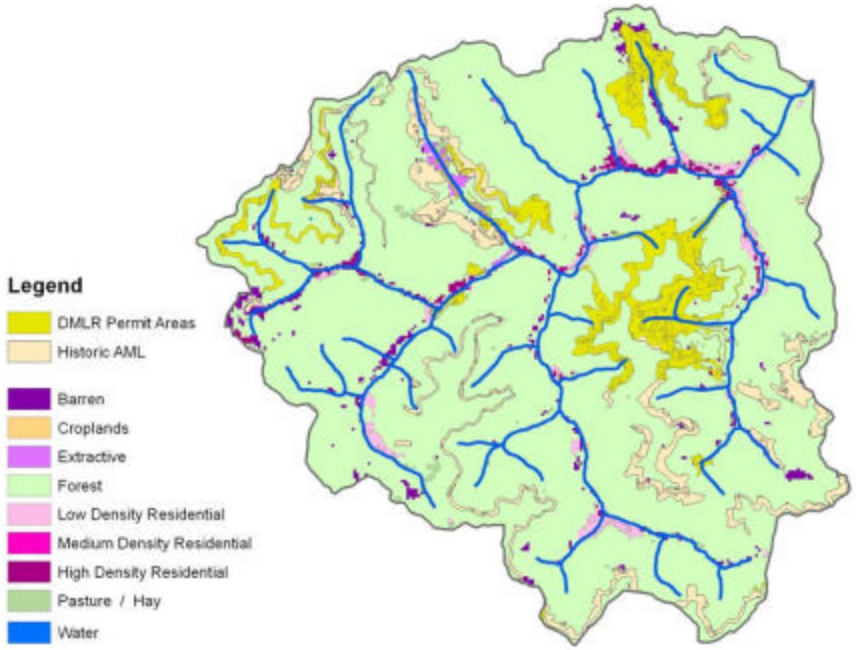
The Sediment Stressor

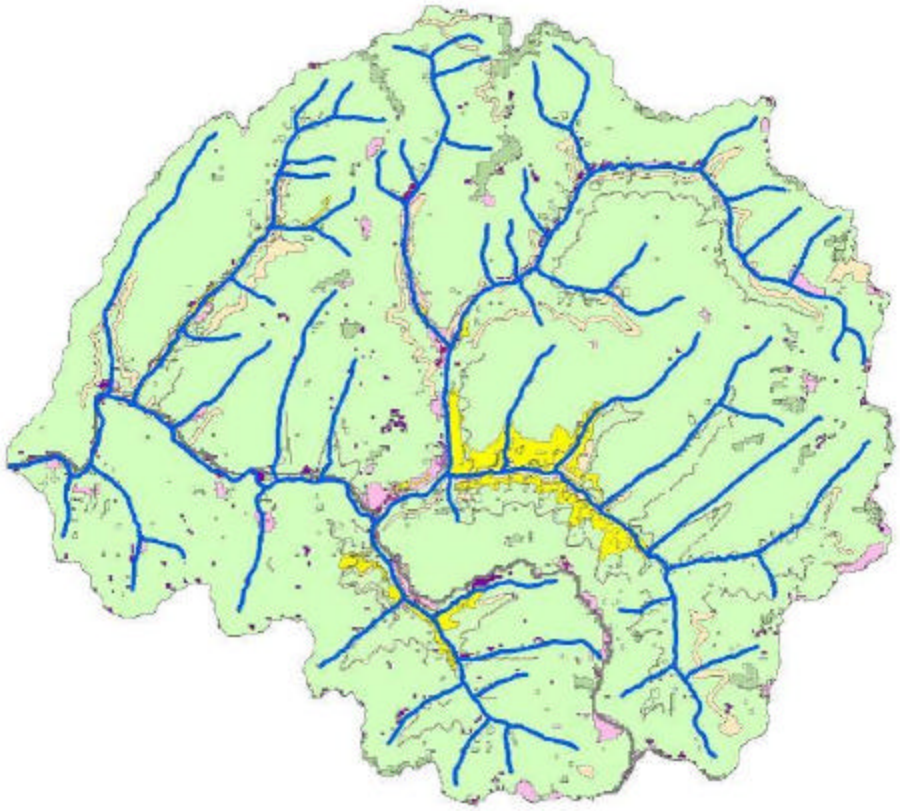
Setting the Sediment TMDL Endpoint for Bull Creek

- No water quality standard for sediment
- No current sediment effluent limitation in mining permits for storms with a greater than 10-yr return interval
- Reference watershed approach
- Endpoint – simulated average annual Load

Reference Watershed Selection for Sediment

Bull Creek





Upper Dismal Creek

Justification for Selection of Upper Dismal Creek

- Similarities with Bull Creek
  - History of mining
  - High % forest; minimal % urban and agriculture
  - Same Cumberland Mountains sub-ecoregion of the Central Appalachians
  - Average slope and soil erodibility
- Non-impaired

Sediment Modeling

- GWLF model
- Bull Creek – 18 sub-watersheds
- Endpoint: average annual load
  - Reference Watershed: Upper Dismal Creek
- 13-year simulation (1995 – 2007)
  - Bull Creek – Grundy weather data
  - Upper Dismal Creek – Richlands weather data

Modeling Land Use Categories

Modeled Land Use Categories	Bull Creek (ha)	Area-Adjusted Upper Dismal Creek (ha)
Cropland	2.8	0.3
Pasture	25.7	49.2
Hay	0.7	0.0
Forest	2,686.9	2,806.5
Barren	62.8	24.9
Mining*		
Extractive	15.0	3.9
Reclaimed	9.7	2.7
Released	19.7	2.9
AML	212.4	149.2
LDR - pervious	52.4	53.6
MDR - pervious	1.9	0.1
HDR - pervious	10.7	9.8
LDR - impervious	7.2	7.3
MDR - impervious	0.8	0.1
HDR - impervious	19.9	18.1
Total Area	**3,128.5**	**3,128.5**
% Forest	85.9%	89.7%
% Agriculture	0.9%	1.6%
% Urban/residential	3.0%	2.8%
% Mining	8.2%	5.1%
% Barren	2.0%	0.8%

* The portion of permitted mining areas "To Be Disturbed" are included in the Forest category.

Simulating Sediment Loads with GWLF

- Surface runoff from all land uses
- Erosion modeling from all land uses
- Channel and stream bank erosion

Accounting for Existing BMPs

- NPDES Sediment ponds
- Variably effective by storm intensity and duration, installation and maintenance
- Average effectiveness for sediment removal (85%)
- Reduce loads from extractive and reclaimed land uses in each sub-watershed (with ponds)

GWLF Model Calibration

- Why calibrate?
  - GWLF developed for use without calibration
    - Previous modeling loads were large relative to observed data
  - Historically, GWLF used for relative reductions
    - From non-permitted sources
    - Restoration purely based on benthic macro-invertebrates
  - Bull Creek
    - Permitted waste loads are monitored and tracked
    - Quantitative loads and reductions are essential

Existing Sediment Loads (t/yr)

Sediment Sources	Bull Creek	Area-Adjusted Upper Dismal Creek
Cropland	11.7	1.1
Pasture	8.2	34.5
Hay	0.1	0.0
Forest	398.9	374.3
Barren	1,226.4	280.3
Mining		
Extractive	428.3	21.8
Reclaimed	8.4	1.4
Released	23.9	4.1
AML	3,890.3	2,017.6
Pervious Urban	9.9	7.5
Impervious Urban	6.1	2.7
Channel Erosion	26.0	14.4
Watershed Totals	**6,038.3**	**2,759.7**

TMDL Endpoint for Bull Creek

Existing Permitted Sediment TSS Loads

Permit_ID	Facility Name	Permitted TSS Loads				
		Drainage Area (acres)	Modeled Runoff (cm/yr)	Permitted Max Conc (mg/L)	Permitted Annual Load (t/yr)	
DMLR Mining Permits						
1101701	STARR BRANCH STRIP	47.91	18.81	70	2.55	
1101736	BURNT POPLAR SURFACE MINE #1	121.52	18.81	70	6.48	
1101903	HAWKS NEST SURFACE MINE	2.73	18.81	70	0.15	29.36
1101979	JESS FORK MINE	64.01	18.81	70	3.41	
1200129	SUPREME ENERGY CORPORATION	0.85	18.81	70	0.05	
1200281	MINE #1	6.10	18.81	70	0.33	
1200343	K & H COAL COMPANY	5.38	18.81	70	0.29	
1201678	APOLLO MINE #1	2.63	18.81	70	0.14	
1201922	MINE #1	12.02	18.81	70	0.64	
1201940	CLINTWOOD ELKHORN H-1 MINE	5.67	18.81	70	0.30	
1601788	CONVICT HOLLOW REMINING PERMIT	281.91	18.81	70	15.02	
DGO Gas Well Permits						
	Existing Allocation for Well Construction	47	1.59	60	0.18	0.18

Modeled runoff =

average annual runoff from the “extractive” land use for mining permits

average monthly runoff from the “barren” land use for gas well permits.

Future Growth Allocation for Sediment

- Mining
  - 10% increase in permitted mining acreage
  - 55 acres
  - Increased TSS = 2.93 t/yr
- Gas & Oil Well Construction
  - 2 new wells / year
  - 7 acres each (14 acres total)
  - Increased TSS = 0.05 t/yr

Bull Creek Sediment TMDL

TMDL (t/yr)	WLA** (t/yr)			LA (t/yr)	MOS (t/yr)
2,759.7	32.5			2,451.2	276.0
	Existing Mining Permits: 29.36				
	Mining Permit Numbers	NPDES MPIDs	Permit WLAs		
	1101701	0003437, 0003438, 0003440, 0003441, 0003442	2.55		
	1101736	0003572, 0003573, 0003574, 0003575, 0004887, 0005632	6.48		
	1101903	0006747, 0006748, 0006749, 0006750, 0006751, 0006752	0.15		
	1101979	0006435, 0006436, 0006437, 0006438, 0006439, 0006440, 0006441, 0006442, 0006443, 0006444, 0006445, 0006446, 0006447, 0006448, 0006449, 0006450, 0006451, 0006452	3.41		
	1200129	none	0.05		
	1200281	5683359	0.33		
	1200343	5640069, 5653489	0.29		
	1201678	5684527	0.14		
	1201922	0003439, 0004312, 0006086, 0006087, 0006397	0.64		
	1201940	0005964, 0005965	0.30		
	1601788	0004449, 0004450, 0004451, 0004452, 0004453, 0004454, 0004455, 0004456, 0004457, 0004458, 0004459, 0004460	15.02		
	Future Mining Permits: 2.93				
	Existing Well Construction: 0.18				
	Future Well Construction: 0.05				

Allocation Target Load = TMDL – MOS = 2,483.7

Sediment Load Allocation Scenarios

Source Category	Existing Bull Creek Sediment Load	Bull Creek % Reductions and Resulting Sediment Loads					
		TMDL Alternative 1		TMDL Alternative 2		TMDL Alternative 3	
	(t/yr)	(% reduction)	(t/yr)	(% reduction)	(t/yr)	(% reduction)	(t/yr)
Cropland	11.7	0%	11.7	0.0%	11.7	0%	11.7
Pasture/hay	8.3	0%	8.3	0.0%	8.3	0%	8.3
Forest	398.9	0%	398.9	0.0%	398.9	0%	398.9
Barren	1,226.4	**63.7%**	444.8	**69.5%**	374.4	0%	1,226.4
Mining							
Extractive	428.3	**63.7%**	155.3	0%	428.3	0%	428.3
Reclaimed	8.4	**63.7%**	3.0	0%	8.4	0%	8.4
Released	23.9	**63.7%**	8.7	0%	23.9	0%	23.9
AML	3,890.3	**63.7%**	1,410.9	**69.5%**	1,187.7	**91.4%**	335.7
Pervious Urban	9.9	0%	9.9	0.0%	9.9	0%	9.9
Impervious Urban	6.1	0%	6.1	0.0%	6.1	0%	6.1
Channel erosion	26.0	0%	26.0	0.0%	26.0	0%	26.0
Total	6,038.3		2,483.7		2,483.7		2,483.7
The TMDL target load for each alternative scenario is the TMDL minus the MOS.							

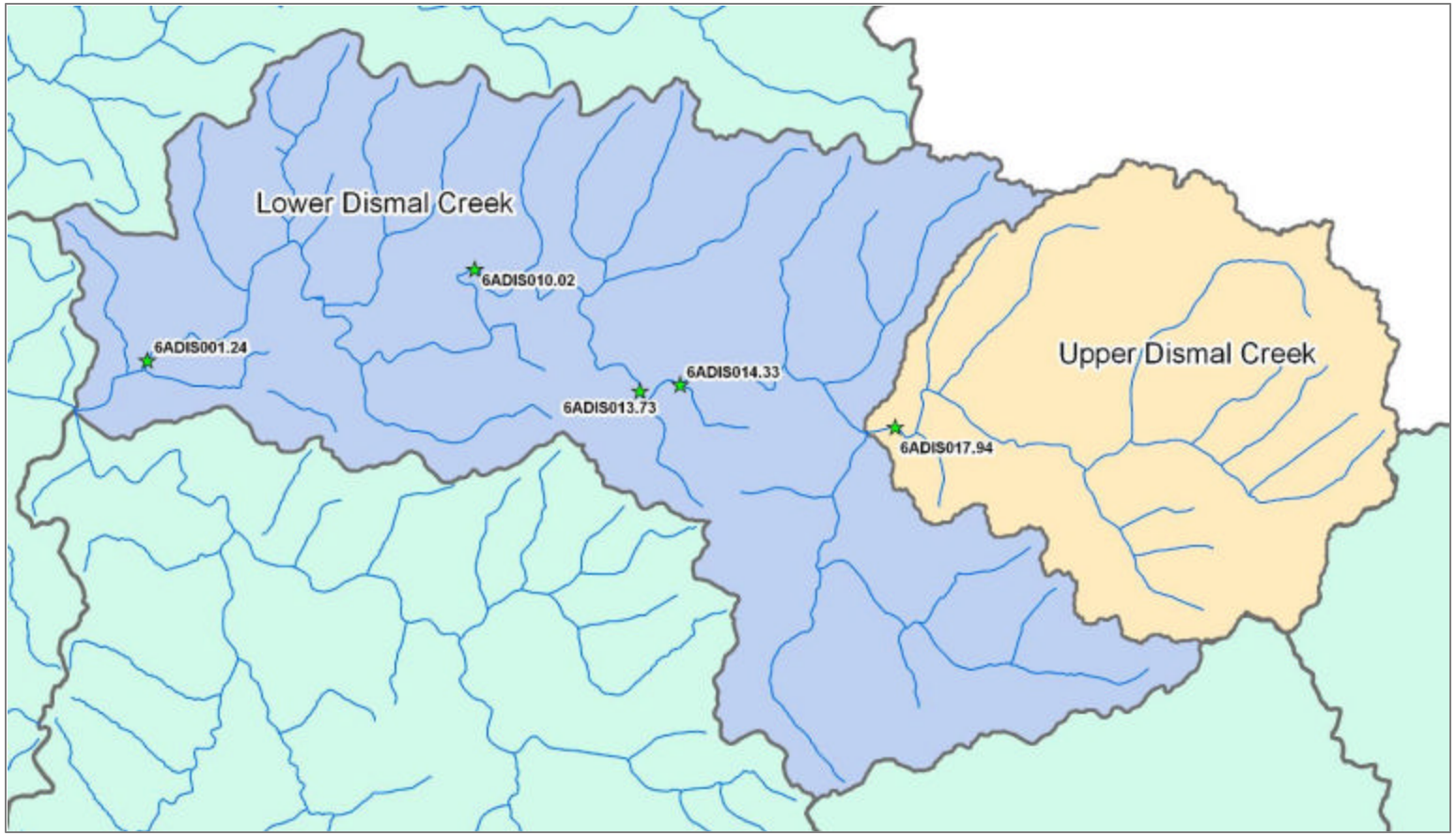
Overall sediment reduction = (6,038.3–2,483.7)/6,038.3 = 58.9%

The Total Dissolved Solids (TDS) Stressor

Setting the TDS TMDL Endpoint for Bull Creek

- No water quality standards for TDS
- No current TDS criteria in mining permits
- Reference watershed approach
- Endpoint - 90th percentile concentration (369 mg TDS/L)
  - Lower Dismal Creek

Upper and Lower Dismal Creek



Justification for Lower Dismal Creek

- DEQ monitored TDS data available downstream at 6ADIS001.24
- Not impaired (6ADIS003.52 or 6ADIS017.94)
- Similarities with Bull Creek
  - History of mining, though smaller percentage
  - Same Cumberland Mountains sub-ecoregion of the Central Appalachians
  - Average slope and soil erodibility
- Has been used as the reference for the Knox Creek TDS TMDL in the same county

TDS Modeling

- HSPF model
- Bull Creek – 18 sub-watersheds
- Grundy weather data
- Hydrology calibration based on Cranes Nest River, refined with observed DMLR in-stream concentrations
- TDS multi-reach calibration with observed DMLR in-stream concentrations

Sources of TDS

- mining activities
- abandoned mine land (AML)
- pre-law mine discharges
- straight pipes and failing septic systems
- road salts
- background

Simulating TDS Sources in HSPF

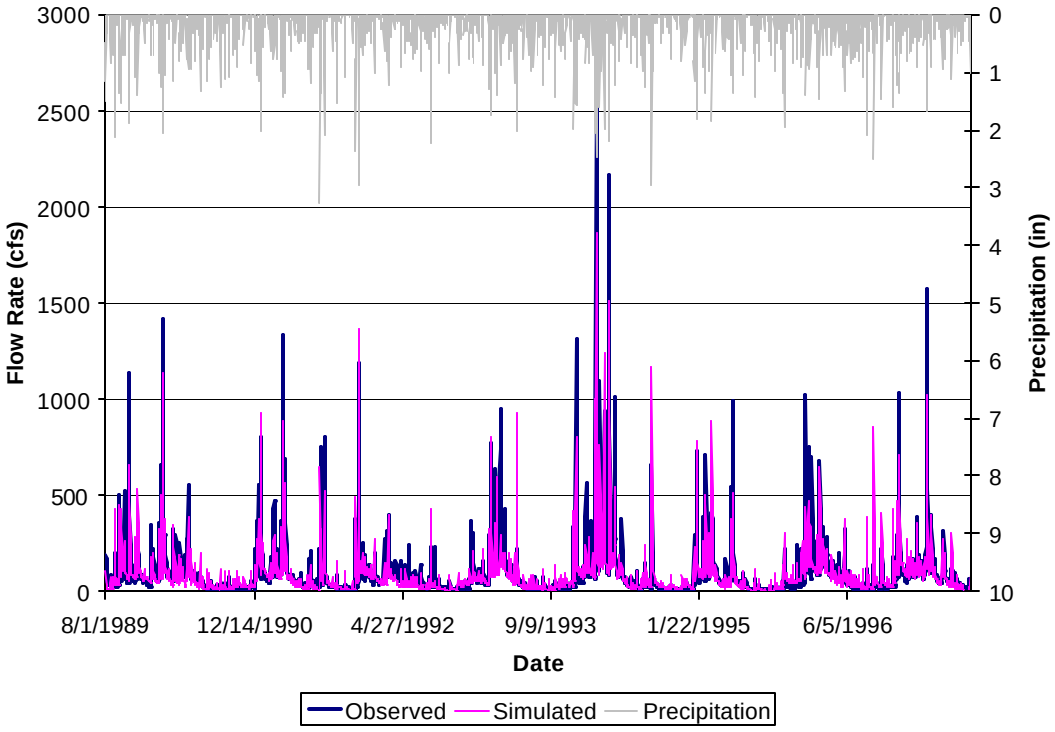
- Surface Buildup subject to Runoff
  - Permitted Mining Areas (extractive and reclaimed)
  - Abandoned Mine Land (AML)
  - Road salt
- Contributions from Interflow and Groundwater (combined background and mining)
- Point Sources
  - Straight pipes and failing septic systems
  - Pre-law mine discharges – direct to stream

Monthly TDS Time-series Inputs in HSPF

- Road salt buildup
  - VDOT application rate
  - named paved roads
  - time-series of days with snow events > 0.5 inches
- Groundwater
  - Average monthly DMLR groundwater concentrations by sub-watershed

Initial Hydrologic Calibration

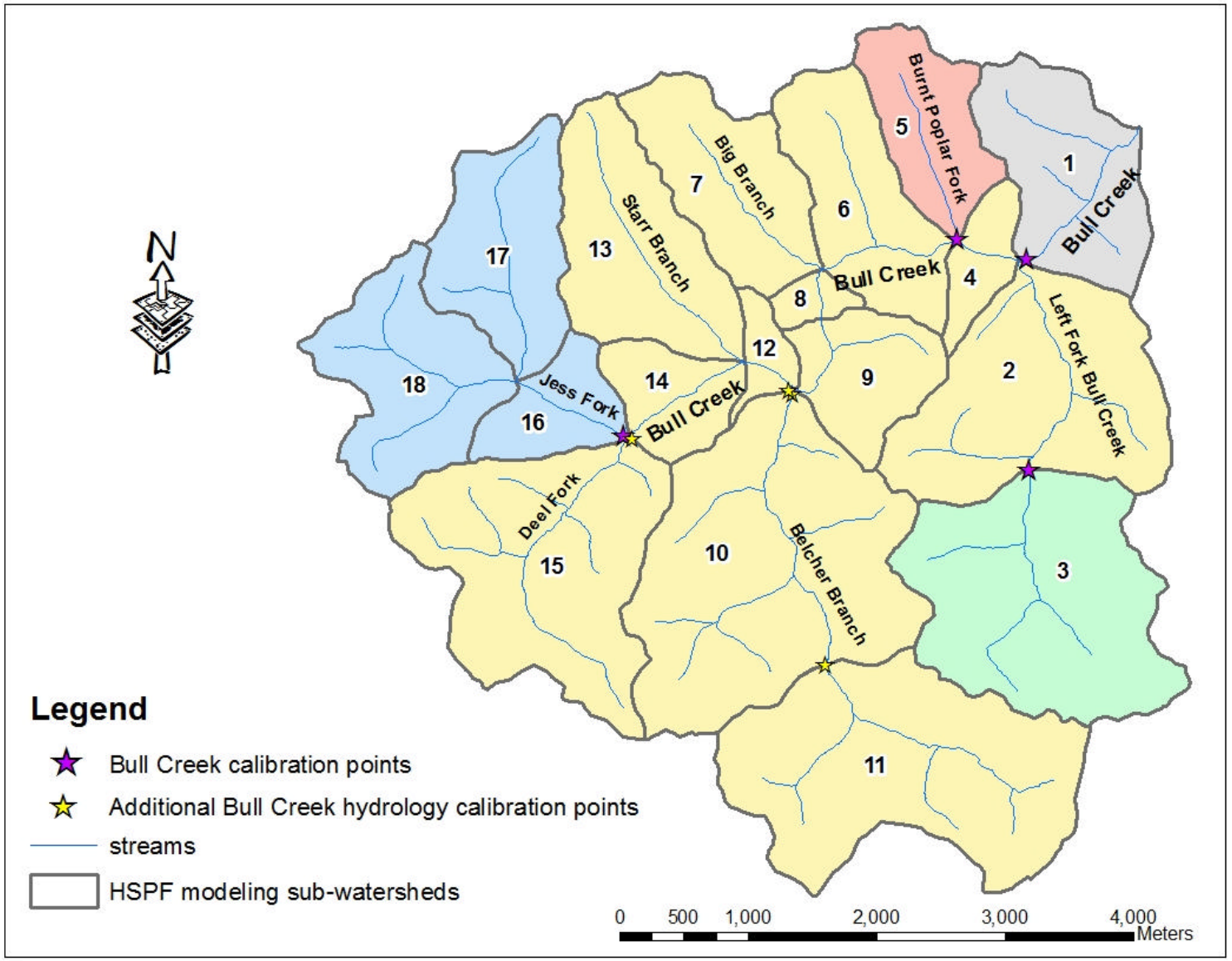
- No continuous flow gauge on Bull Creek
- USGS flow data from nearby Cranes Nest River
- Calibration performed using HSPEXP



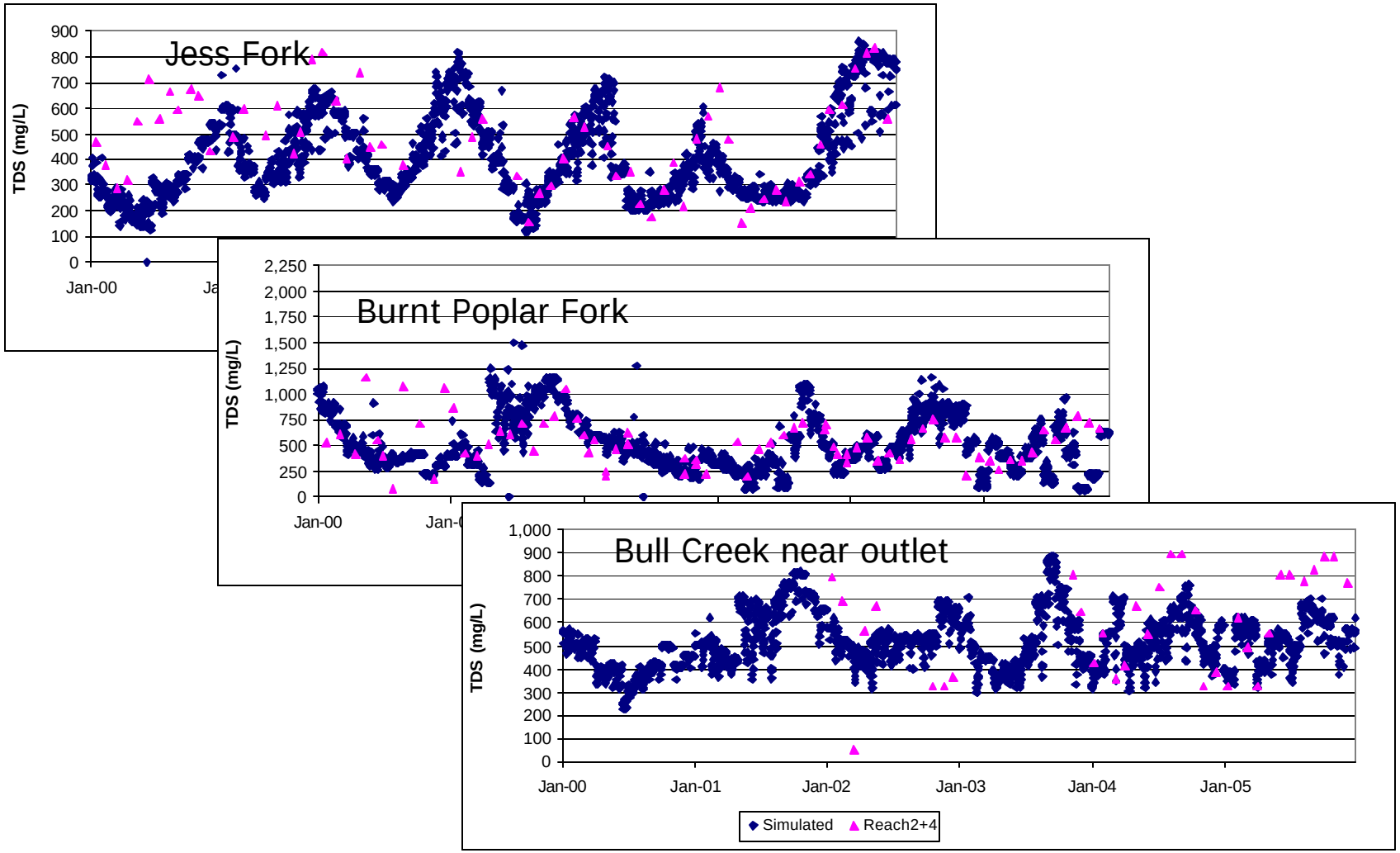
Calibration with DMLR Data

- Hydrology:
  - Fine-tune calibrated parameter values from Cranes Nest River
  - Entire period of DMLR electronic data (Jan 1994 – Dec 2006)
- TDS:
  - Land use changes occurred during the DMLR monitoring period
  - More recent period selected to be representative of mining activities (Jan 2000 – Dec 2005)
  - Same period used for calibration and TMDL modeling

Location of DMLR Calibration Points



Multiple-Point TDS Calibration with DMLR In-stream Data



Existing TDS Loads

TDS Sources	Bull Creek Existing TDS Load	
	(kg/yr)	(%)
Permitted Mining	2,976,342	49.4%
Mine Discharge	1,834,292	30.5%
AML	600,924	10.0%
Background	563,863	9.4%
Road Salt	18,565	0.3%
Residential	28,063	0.5%
Total	**6,022,048**	

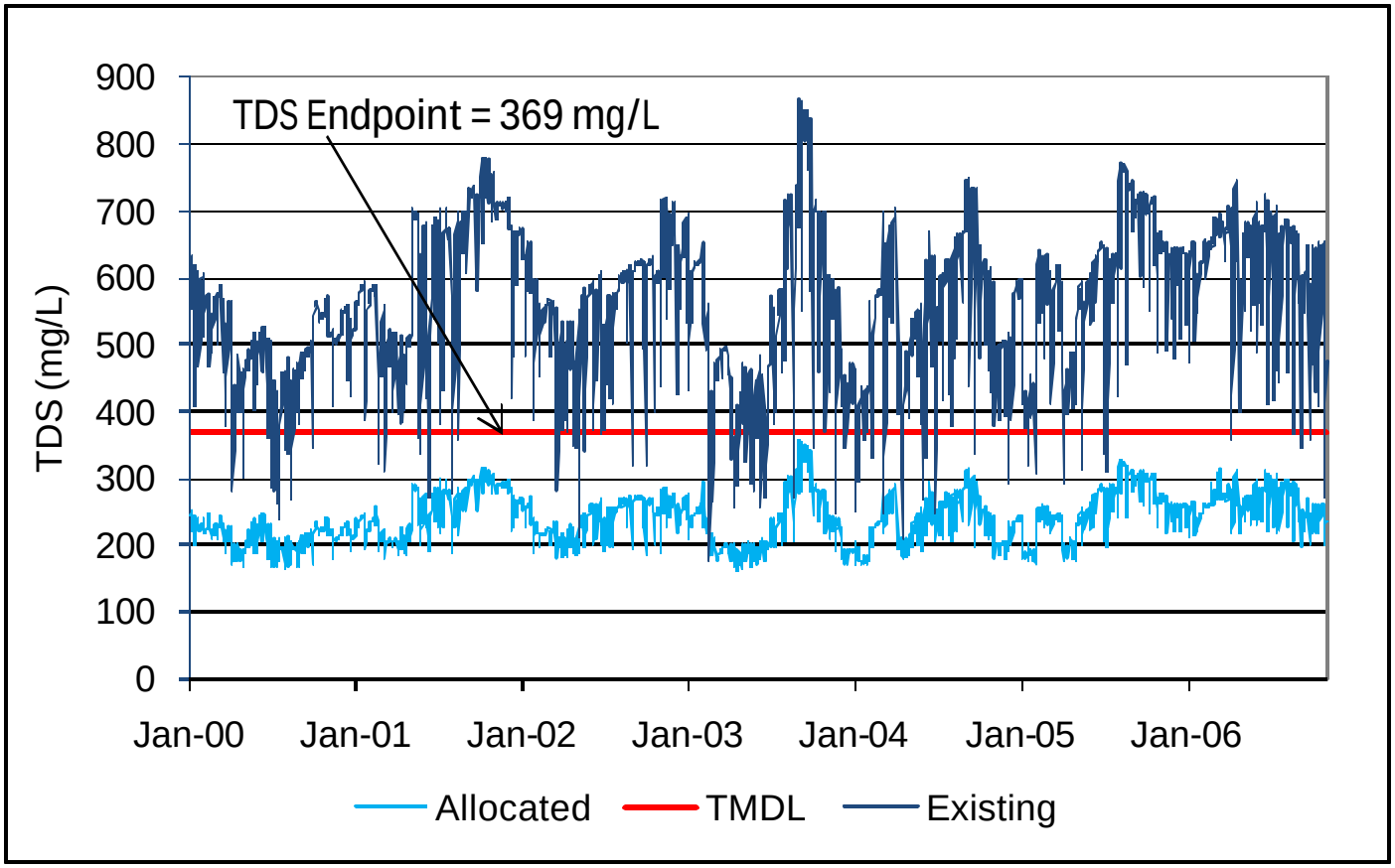
TDS Load Allocation Scenarios

Scenario	Reductions by Source (%)								Max Ave Daily TDS (mg/L)	No. > 369 mg/L	TDS Load (kg/yr)
	Mining		AML		Mine Discharge	Background	Road Salt	Residential			
	IF + GW	Surface Runoff	IF + GW	Surface Runoff							
0	0	0	0	0	0	0	0	0	881	2,083	6,022,048
1	0	0	100	100	0	0	0	100	848	1,976	5,393,061
2	60	60	100	100	60	0	0	100	340	0	2,523,735
3	58	58	100	100	58	0	0	100	356	0	2,619,394
4	55	55	100	100	55	0	0	100	382	9	2,762,875
5	56	56	100	100	56	0	0	100	373	1	2,715,051
6	0	0	100	100	100	0	0	100	638	410	3,558,770
7	20	20	100	100	100	0	0	100	511	107	2,969,239
8	40	40	100	100	100	0	0	100	383	9	2,379,673
9	43	43	100	100	100	0	0	100	364	0	2,291,231

Residential includes Failing Septic Systems and Straight Pipes.
IF = Interflow; GW = Groundwater.

The overall reduction in TDS loads required = 62.0%

Simulated Existing and TMDL Scenarios



Bull Creek TDS TMDL

Bull Creek (VAS-Q08R_BLC01A98)					
TMDL	**WLA***			**LA****	**MOS**
2,291,231	**1,708,803**			**582,427**	**Implicit**
	Mining Permit Numbers	**NPDES MPIDs**	**Permit WLAs**		
	1101701	0003437, 0003438, 0003440, 0003441, 0003442	244,580		
	1101736	0003572, 0003573, 0003574, 0003575, 0004887, 0005632	319,156		
	1101903	0006747, 0006748, 0006749, 0006750, 0006751, 0006752	141,159		
	1101979	0006435, 0006436, 0006437, 0006438, 0006439, 0006440, 0006441, 0006442, 0006443, 0006444, 0006445, 0006446, 0006447, 0006448, 0006449, 0006450, 0006451, 0006452	90,042		
	1200129	none	44,005		
	1200281	5683359	17,659		
	1200343	5640069, 5653489	20,102		
	1201678	5684527	186,949		
	1201922	0003439, 0004312, 0006086, 0006087, 0006397	41,181		
	1201940	0005964, 0005965	41,286		
	1601788	0004449, 0004450, 0004451, 0004452, 0004453, 0004454, 0004455, 0004456, 0004457, 0004458, 0004459, 0004460	562,685		

** LA includes loads from Road Salt and Background Interflow contributions.

Suggested First Things To Do

- Remining and reclamation of AML areas
- Establish vegetative cover on barren areas
- Establish stream buffers near riparian residential/urban areas
- Use BMPs that reduce the disturbed surface footprint
- Cover exposed materials with soil to prevent weathering and reduction of metals
- Conduct additional TSS and TDS monitoring to improve characterization of sources
- Any TSS > 70 mg/L should trigger a re-assessment of BMPs recommended in DMME guidance

Contact Information

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- Bull Creek TMDLs (Benthic Impairment)

http://www.deq.state.va.us/tmdl/develop.html